Water Resources Assessment and Research Subactivity

Program	1999 Estimate	Uncontrol. & Related Chgs	Program Redirect	Program	FY 2000 Budget Request	Change from 1999
Ground-Water Resources	3,170	96	-851	0	2,415	-755
National Water-Quality Assessment	71,593	2,165	-12,532	0	61,226	-10,367
Toxic Substances Hydrology	**14,659**	**433**	**-3,284**	**474**	**12,282**	**-2,377**
Hydrologic Research & Development	15,011	450	-2,786	-300	12,375	-2,636
Total Requirements $000	104,433	3,144	-19,453	174	88,298	-16,135

Note: The Program Redirect column reflects the redirection of funds to the Integrated Science, Science Support, and Facilities activities.

Toxic Substances Hydrology

Current Program Highlights

The USGS Toxic Substances Hydrology (Toxics) Program provides water resource managers with earth science information on the behavior of toxic substances in the Nation's surface waters and ground waters. This information is used to develop policies and action plans that help to avoid human exposure to toxic substances, develop cost-effective remedial strategies, and prevent further contamination. The Toxics Program identifies and investigates those particular types of hydrologic contamination that pose high risks to human and/or environmental health and that are widespread across the Nation. The Program has three major components: Intensive Field Investigations, Regional Investigations, and Methods Development and Process Oriented Research. The Program works in partnership with the U.S. Environmental Protection Agency (EPA), U.S. Department of Agriculture (USDA), Federal land management agencies, Department of Defense, Department of Energy, and Nuclear Regulatory Commission to ensure that research priorities are coordinated with their needs and ongoing activities. The results of Toxics Program studies are distributed at briefings for regulatory agencies and industry groups, at USGS-sponsored workshops, at national scientific meetings, in USGS reports and fact sheets, and in papers published in scientific journals and books. Information about the program is available on the World Wide Web at: **http://toxics.usgs.gov/toxics/**.

Intensive Field Investigations — Intensive field investigations are conducted at sites where toxic substances have been released from point sources. These sites serve as natural laboratories where scientists conduct experiments and long-term observation and process

research. Knowledge and methods developed at the sites are transferable to many other sites across the Nation. Examples of intensive field investigations currently being conducted are:

- **Oxygenated Gasoline at Laurel Bay, South Carolina** — Oxygenated gasoline containing the fuel oxygenate MTBE (methyl tert-butyl ether) leaked from an underground storage tank at the Laurel Bay Exchange Marine Air Station, resulting in a plume of contaminated ground water in a shallow sandy aquifer. The presence of MTBE in the plume along with the traditional compounds that pose an environmental and human health risk is significant, because MTBE travels faster and farther than the other compounds of concern. As such, the presence of MTBE confounds the natural attenuation remediation alternative--the most common and efficient cleanup alternative for gasoline spills. Information gathered at the site has provided the first comprehensive documentation of the advance of MTBE ahead of other gasoline compounds, is helping to define the basis for the long-term threat of MTBE to water resources and water supply, and is defining the potential for natural attenuation of oxygenated fuels.

- **Radioactive and Hazardous Wastes in the Amargosa Desert, Nevada** — In areas with arid climates, thick unsaturated zones (the zone between the land surface and the water table) are considered effective disposal sites for radioactive and hazardous wastes. The Toxics Program's Amargosa Desert Research Site is located adjacent to a low-level radioactive and hazardous waste disposal facility. Research at the site has focused on quantifying the processes that control the movement of water and gases and the potential for associated migration of contaminants. Recently, radioactive hydrogen (tritium) and carbon were detected moving off

USGS Advances Natural Attenuation Remediation Technology

Research of the USGS Toxics Program has emphasized characterizing the natural processes that affect the movement and fate of environmental contaminants. Research on the natural attenuation of oxygenated gasoline at Laurel Bay, South Carolina; of crude oil at Bemidji, Minnesota; of solvents at Picatinny Arsenal, New Jersey; and on other contaminants at other locations has been used as a basis for advancing the use of natural attenuation as an effective remediation technology. Based on natural attenuation technologies the USGS has:

- Co-authored guidance documents on the use of natural attenuation at ground-water cleanup sites, published jointly by the U.S. Air Force and the EPA. These guidance documents are widely used by professionals designing remediation plans for contamination sites.
- Co-sponsored with the EPA a series of workshops on implementing monitored natural attenuation at cleanup sites. The two agencies conducted workshops at 9 locations that reached thousands of engineers, scientists, and resource managers across the Nation.
- Developed a methodology to assess the potential for natural attenuation of MTBE at gasoline spill sites. This methodology is being adopted by the South Carolina Department of Health and Environmental Control to integrate consideration of fuel oxygenates (such as MTBE) into the State Underground Petroleum Emergency Response Bank program.
- Co-sponsored and participated in a National Academy of Science, National Research Council study on Intrinsic Remediation of Contaminants in Subsurface Environments. The object of the study was to evaluate the limitations of natural attenuation and provide information that can be used to design effective remediation plans at contamination sites.

site from the waste disposal facility, and as a result, research at the site has focused on evaluating the processes by which these contaminants move in arid environments. New information on the processes that control contaminant migration and models that enable simulation of those processes are being developed and will enable improved design and siting of waste disposal facilities in arid regions.

Additional intensive field investigations include studies of: a petroleum pipeline leak near Bemidji, Minnesota; a treated sewage-effluent release on Cape Cod, Massachusetts; a gasoline spill in Galloway, New Jersey; a leachate plume at a municipal landfill in Norman, Oklahoma; a release of industrial solvents at the Picatinny Arsenal, New Jersey; and contaminant movement in fractured-rock aquifers near Mirror Lake, New Hampshire.

Regional Investigations — Regional investigations are conducted in large areas that have land uses and other human activities that can introduce toxic contaminants to the environment from non-point sources. The investigations develop methods to detect and monitor the contaminants, to identify the extent and degree of contamination associated with the selected land use, to define the processes that transport and transform these substances into different and possibly more toxic forms, and to evaluate potential ecological implications. Ongoing regional investigations include studies of:

- Atmospheric Mercury in Aquatic Ecosystems — Industrial activities have significantly increased mercury transport through the atmosphere, resulting in accumulation of a toxic form of mercury (methyl mercury) even in remote lakes and streams. Methyl mercury accumulates in the food chain, threatening fish-eating wildlife and human health. In the first year of this USGS study, data on various forms of mercury in water, sediment, and fish have been collected at 106 sites from 21 major hydrogeologic regions across the Nation. High mercury levels are being found in areas where atmospheric deposition is predicted to be high, in mining areas, and surprisingly in Oahu, Hawaii, perhaps providing the first documentation of mercury contamination from volcanic activity. Preliminary results indicate that four study basins affected by atmospheric deposition along the east coast (New England Coastal Basins, Santee Basin in the Carolinas, Long Island and New Jersey Coastal Drainage, and Southern Florida) have the greatest methyl mercury production. Preliminary indications are that the density of wetlands plays an important role in methyl mercury production in areas affected by atmospheric deposition. Other causal factors that are being tested include the chemistry of sediment and water.

- Agricultural Chemicals in the Midwest — The corn and soybean growing area of the Midwest has the highest annual application of herbicides and fertilizer in the United States. The USGS is determining the occurrence, distribution, movement, and fate of agricultural chemicals in the region's surface-water and ground-water systems. The results are aiding local, State, and Federal agencies in reaching cost-effective decisions about the use of agricultural chemicals and the monitoring and use of affected water resources.

Other regional investigations include studies of cotton pesticides across the southern United States.

Methods Development and Process Oriented Research — Improved scientific knowledge and methods of characterization and simulation are being developed for environmental processes that affect a broad range of contamination problems. Methods development activities include development of: (1) computer simulation models to quantify processes occurring at field sites and to design remedial strategies; (2) new methods for making field measurements of physical, chemical, and biological features of contaminated sites; and (3) laboratory analytical methods to detect and monitor new contaminants, measure the chemical form of a contaminant, and detect familiar contaminants at lower levels. Process oriented research develops knowledge of the fundamental ways contaminants move and react in surface water and ground water. This process research complements the work that is done at the field sites, delving more deeply into the specific hydraulic, geochemical, and microbial processes through field or laboratory experiments. Examples of investigations conducted under the Methods Development and Process Oriented Research part of the Program include:

- USGS scientists are identifying new chemical compounds that are suspected to be entering the environment and are suspected to pose a threat to human and environmental health. The analytical methods are developed and tested on environmental samples collected from susceptible areas across the Nation. Developed methods include those for fuel oxygenates and degradation products, for new pesticides and the degradation products of widely used pesticides, and for selected chemicals used in industrial processes. Methods are currently under development for selected new pesticides and pharmaceutical chemicals produced for both human consumption and domestic animal production.

USGS Abandoned Mine Lands (AML) Initiative

The USGS AML initiative is developing and demonstrating scientific knowledge and technologies that will help Federal land management agencies clean up contamination in areas near abandoned hardrock mines across the Nation. The Initiative is being conducted in two pilot watersheds, the Upper Animas River watershed in Colorado and the Boulder River watershed in Montana, where the USGS is partnering with the U.S. Forest Service, BLM, NPS, EPA, and State agencies in Colorado and Montana. These agencies are using USGS scientific information to establish priorities and design cleanup activities in the watersheds. Initiative contributions include:

- Tracer tests, in which a harmless tracer such as dye is put into a stream and its downstream movement is measured and modeled. These tests are successfully identifying the largest sources of contamination from abandoned mine lands, and are enabling efficient targeting of cleanup activities.
- Water quality and flow measurements that define seasonal and other temporal variations in contaminant movement. Such studies show that zinc levels in the upper Animas River exceeded the standards proposed by the Colorado Water Quality Control Division approximately 354 days a year.
- Methods to determine the environmental conditions that existed before mining began in order to establish realistic clean-up goals. In some mined areas, water quality was affected by the natural weathering of mineral deposits before mining occurred.
- Documentation of the downstream movement of metal contamination associated with ultra-fine particles that accumulate in the bottom sediment of rivers and streams. This method of contaminant migration was found to be significant to exposure of aquatic organisms and deterioration of ecosystem health.
- Findings that metal concentrations in fish and aquatic insects were higher than in the surrounding water and bottom sediments, indicating that metals (some of which are toxic) are accumulating in the local food chain.

Additional information about the AML Initiative can be found at: **http://amli.usgs.gov/amli/**.

- Researchers working at the Norman Landfill Site, Oklahoma, have developed a method of sampling the leaves of plants (in this case, cottonwoods) whose roots extend to the water table, to determine the location of contaminated ground water. In the appropriate settings, the method is much faster and less expensive than geophysical methods or drilling monitoring wells, and should be effective for a broad range of contaminants. Use of this method could save millions of dollars annually in characterization costs at contaminated sites across the United States.

Recent Accomplishments

USGS Demonstrates the Importance of How Pesticides Degrade in the Environment — After pesticides are applied, they break down or degrade into a variety of compounds, some of which are more toxic than their parent compounds. The Toxics Program is developing methods to detect these breakdown products (degradates) in water samples. Results of recent studies on the occurrence of degradates using these new methods show that during the post planting period (May-June, 1998), when pesticide levels reach their maximum, the levels of herbicide degradates in water samples from Midwestern streams was similar to the levels of the parent compounds. In effect, this doubles the amount of toxic compounds in stream waters, and can increase human exposure to herbicide compounds. Accurate assessment of the risk of exposure to herbicides in water resources would not be possible without these new methods to measure degradates in water samples.

USGS Develops Methods to Measure a New Generation of Pesticides — Every year new pesticides are developed that can be used in increasingly smaller and smaller quantities, which makes them increasingly difficult to detect in the environment. Very little is known about the fate of this new generation of pesticides in the environment. The USGS, in conjunction with Du Pont Chemical Company, developed a method to measure 16 sulfonylurea herbicide compounds--a new type of herbicide that is applied in extremely small amounts. Eighty percent of the samples collected from Midwestern streams contained detectable quantities of the sulfonylurea herbicides. This is the first time that the occurrence and distribution of these compounds has ever been documented in water resources at a regional scale and is an important initial step to assessing their effects in the environment.

Nutrients from the Mississippi River and Hypoxia in the Gulf of Mexico — USGS scientists are participating in the Committee on Environment and Natural Resources' (CENR) integrated assessment of the causes and solutions for hypoxia in the Gulf of Mexico. The CENR assessment is being conducted at the request of the White House Office of Science and Technology Policy. Hypoxia is a condition where water is very low in dissolved oxygen, and scientists believe it is caused by the flow of large quantities of nutrient-rich water into the Gulf from the Mississippi River each year during spring and summer. A report was prepared on the sources and flow of nutrients to the Gulf of Mexico. The report states that the average annual amount of nitrogen (a nutrient) flowing down the Mississippi River and into the Gulf of Mexico is about 1.6 million metric tons per year. The largest inputs of nitrogen to the Mississippi River are from streams draining the Midwest cornbelt States. The report also documents source areas for nitrogen and phosphorus (another nutrient) and provides information on the human activities most responsible for the nitrogen and phosphorus discharged into the Gulf. The largest inputs come from agricultural activities. Results presented in this report are being used

by the Mississippi River and Gulf of Mexico Hypoxia Task Force to design strategies to reduce the amount of nutrients flowing into the Gulf from the Mississippi River and to mitigate the hypoxic conditions in the Gulf.

Natural Degradation of MTBE — USGS scientists are studying the potential for natural degradation of MTBE at gasoline spill sites. MTBE has been used as an octane booster in gasoline since the mid-1970's, and as a fuel oxygenate to achieve reductions in carbon dioxide and ozone in the atmosphere. Studies at the Laurel Bay Research Site, South Carolina, have shown that microorganisms in the subsurface slowly break down MTBE to non-toxic carbon dioxide in ground-water systems. The slow rate of this natural degradation has led to concern that MTBE from gasoline spill sites may accumulate in ground water and surface water, and possibly may affect drinking water supplies. However, new research conducted by the USGS in cooperation with the South Carolina Department of Health and Environmental Control has demonstrated that sediment from the bottom of streams from several sites have a large capacity to degrade MTBE rapidly. These new results demonstrate a previously unknown phenomenon for MTBE, and show that the right combination of microorganisms and the condition of the subsurface exist in nature that could prevent accumulation of MTBE in surface-water bodies used for drinking water supplies. These results are now being used by the South Carolina Department of Health and Environmental Control to develop regulations for MTBE use in South Carolina.

New Tracer-Test Technology Demonstrated in Mining Initiative — A stream tracer-injection technology that identifies and quantifies sources of contamination within watersheds (watersheds that may be affected by hundreds of potential contamination sites) was developed and demonstrated through the Abandoned Mine Lands (AML) Initiative. To date, seven tracer injection studies have been conducted in mountain streams affected by acid mine drainage. After the four tests in the AML Initiative pilot watersheds demonstrated the value of this technique, the EPA and Federal land managers requested that additional tests be conducted in Colorado, Montana, and Utah. In each case, the results enabled them to prioritize resources and target contaminant sources that when remediated will result in the greatest improvement in watershed quality. Additional information on tracer-injection studies can be found at: **http://wwwdutslc.wr.usgs.gov/usgsabout/fs245/245.html**.

USGS Technology Transferred at FRACDAY Workshop — In June 1998, a field demonstration of technologies and field methods--developed and tested at the Mirror Lake New Hampshire research site--was presented to 200 attendees including Federal, State, and local water-resource managers. The workshop was held at an instrumented field site in Hopewell, New Jersey, in the Metropolitan New York area. The purpose of the demonstration was to provide an overview of field techniques that can be used to characterize fractured rock terrain and that could be used to help solve environmental assessment or water supply problems. As a result of the demonstration, USGS scientists were invited to advise Department of Energy decision making regarding the practical limitations of cleaning up contamination at fractured rock sites; and the USGS was asked to participate in Canadian Government sponsored research at the Smithville site in Ontario Canada.

Justification for Program Change

	FY 2000 Request	Program Change
$(000)	12,282	+474

This is a net change resulting from an increase of $1 million and a decrease of $526,000.

Research and Monitoring for Amphibians as an Indicator Species (+$1.0 million) — The proposed increase will enable hydrologic and water quality support for a national assessment of amphibians. This component of the larger Amphibian Assessment which is described in the Biological Research section would include characterization of hydrologic conditions and basic water quality conditions at targeted ecosystems. It will include assessment of potential toxic contaminants that could contribute to amphibian declines, and methods to measure new "emerging" contaminants in the environment, which also may be contributing. These resources will be used to bring expertise from hydrologists, aqueous geochemists, and analytical chemists together with that of biologists, ecologists and other scientists on the amphibian assessment team.

Mercury Assessment (-$0.526 million) — The proposed decrease will postpone a systematic national assessment of selected aquatic ecosystems susceptible to contamination from mercury through atmospheric sources. In a constrained budget climate, it would be imprudent to continue this program activity. The USGS will continue planning for additional mercury work, but to delay the implementation of this work until funding becomes available as other work ends in future years.